

Appl. No. 09/972,200

In re Kunieda et al.

Reply to Office Action of Sept. 10, 2004

**Amendments to the Claims:**

This listing of claims will replace all prior versions, and listings, of claims in the application:

**Listing of Claims:**

Claim 1 (currently amended): A system for fingerprint authentication, ~~which comprises~~  
comprising:

~~which stores, regenerates, or matches a curve recognition system for storing,~~  
regenerating or matching a shape of curves a fingerprint ridge[[,]] by using a specified group  
of data [[in]] including one of a length, and/or angle and/or and position to express a shape of  
curve the ridge, wherein

[[in]] ~~the system~~ the curve recognition system uses a minutia and using a sequence of  
several measure points on the ~~curve~~ fingerprint ridge [[,]] ~~which are determined so as to make~~  
~~the same distances between those~~ selected so that chords connecting the adjacent measure  
points are of equal length, the shape of the fingerprint ridge is characterized by data of lengths  
of chords ~~ares being~~ between a starting measure point and an ending measure point ~~points~~  
among for every 3 consecutive measure points on the curve ridge.

Claim 2 (currently amended): The system as defined in claim 1, wherein the curve  
recognition system is provided for recognition of the curve ridge expressed on ~~the periodic~~ a  
discrete grid grids such as in the form of an array of pixels in a digital image, which

determines position of the measure points by interpolating positions of two nearest adjacent grid pixels on the curve ridge, ~~whose distances wherein from the~~ starting measure point divides a length of a chord between the two nearest adjacent pixels at the ratio of lengths from a standard pixel on the curve to each of the nearest adjacent pixels are less and greater than the specified value, respectively.

Claim 3 (currently amended): ~~[[A]]~~ The system as defined in claim 1 for fingerprint authentication, further comprising in a sequence of processing:

means for block partitioning to partition whole image data into plural pieces of blocks~~[[.]]~~;

means for the first binarization to make gray scale image a binary black and white image by enhancing contrast of original image~~[[.]]~~;

means for deriving directions of the ridge in binary image~~[[.]]~~;

means for noise elimination to eliminate black data not located along directions of ridge~~[[.]]~~;

means for the second binarization to make gray scale image a binary data by enhancing contrast of original images~~[[.]]~~;

means for thinning by reducing width of ridge until ridge width becomes one pixel in size~~[[.]]~~;

means for false minutia elimination to eliminate plural ~~minutia~~ minutiae located closely to each other, an ending minutia located near bifurcation minutia, a minutia located closely to image boundary, and an isolated minutia without ridge, and

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means for extracting minutia to adopt remaining minutia as true minutia after above false minutia elimination.

Claim 4 (currently amended): [[A]] The system as defined in claim 1, wherein [[it]] the system utilizes, as [[a]] an additional feature of fingerprints, both said the minutia ridge shape and said the ridge shape of a secondary minutia, whose position is determined in associated association with each minutia.

Claim 5 (currently amended): [[A]] The system as defined in claim 3, further including wherein two kinds of extraction means for an ending minutia are performed over using the original black and white image and its reversed an inverted version of the original black and white image, instead of extracting both ending and bifurcation minutia over using just the original black and white image.

Claim 6 (currently amended): [[A]] The system as defined in claim 1, wherein it includes further including a cost effective calculation for judging true or false minutia, comprising:

means for taking [[2]] two-dimension coordinates with respect to an origin located at [[of]] a bifurcation point[[.]];

means for taking 3 points on different ridges leaving from the bifurcation point with the same distances from the bifurcation point[[.]];

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means for calculating ~~all~~ inner products of ~~2-point vector selected~~ all pairs of point-vectors that can be obtained from ~~said the 3 point-vector that correspond, respectively, to the 3 points, wherein inner product means sum of multiplication of horizontal components of said the 2 points with each other and multiplication of vertical components of said 2 points with each other~~[[.]]; and

means for judging the bifurcation as a false bifurcation minutia if all ~~3-said~~ calculated inner products are less than a specified value[[.]] , ~~and, Otherwise~~ otherwise, judging the bifurcation as a true bifurcation minutia [[.]]; and

means for judging ridge ending as a false ending minutia by using the ~~similar~~ inner products over valleys if all ~~3-said~~ inner products are less than a specified value , ~~and,~~ [[.]] ~~Otherwise~~ otherwise, judging the ending minutia as a true ending minutia.

Claim 7 (currently amended): [[A]] The system for fingerprint authentication as defined in claim 1, wherein ~~under assumption of consecutive frame inputs of identical fingerprints, [[a]] different part parts of the fingerprint image [[is]] are processed in said a way to generate numerical data for each frame input of the fingerprint image and processing of a whole fingerprint image is completed for plural frame inputs of the fingerprint image.~~

Claim 8 (currently amended): A system for fingerprint authentication, ~~wherein it uses comprising means of judge for judgment on fingerprint verification without compensation for displacement of input fingerprint image, comprising;~~

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means for employing ~~memory area in~~ [[2]] two-dimensional array of memory areas  
~~coordinates for judge judgment~~ [[.]];

means for calculating a similarity measure for each pair of minutia data between input  
fingerprint image and registered template fingerprint [[.]];

means for accumulating the similarity measure, wherein the similarity measure is  
stored in the memory area[[,]] ~~whose corresponding to that of a~~ coordinates are the same as  
vectors vector between the positions of the said ~~2~~ two minutiae ~~minutia~~. ~~The similarity~~  
~~measure means any numerical data to express similarity between 2 minutia~~ [[.]];

means for judging input fingerprint as the same registered one if ~~the~~ a maximum value  
in the memory area exceeds a specified value.

Claim 9 (canceled)

Claim 10 (currently amended): [[A]] The curve recognition system as defined in claim  
7, ~~wherein under assumption of consecutive several frame inputs of identical fingerprint, it~~  
takes 6<sup>th</sup> frame in a raster scan system of 25 frames per second ~~seconds~~ to complete processing  
from image capture to numerical processing, which corresponds to input time of 6 or 7  
frames.

Claim 11 (currently amended): [[A]] The system as defined in claim 1 ~~for fingerprint~~  
~~authentication~~, comprising:

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means for extracting ~~said~~ numerical data of ~~said~~ the fingerprint ridge shapes of the ridge leaving from ~~said~~ the minutia[.]; and

means for matching the numerical data with template samples registered in advance [[or]] in a fingerprint database in said way.

Claim 12 (currently amended): [[A]] The system as defined in claim 1, wherein ~~on~~ ~~100-MOPS~~ a computer[[, it]] performs a sequence of processing ~~as said~~ including thinning, ~~said improvement or said compensation, said binarization, said thinning, said collection and said matching of fingerprint feature data expressed by 40 or 60 bytes data in size. MOPS means unit of operation speed of computer, which represents million operations in one second.~~

Claim 13 (currently amended): [[A]] The system as defined in claim 1, further comprising:

means for extracting ~~said~~ fingerprint feature data of 40 or 60 bytes from ~~said~~ a fingerprint template transferred from an outer device or terminal equipment[.]; and

means for transferring result of matching with ~~said~~ the templates through communication network to the outer device or terminal equipment.

Claim 14 (currently amended): [[A]] The system as defined in claim 1, wherein [[it]] the system is used with one of a terminal or stand-alone equipment[[,]] ~~which posses a function such as search~~ for personal history, a key lock, an issue of various tickets, an access

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control and toll of gates, electric commerce, and a fund management in medical, social welfare, service, public service, and financial organization.

Claim 15 (currently amended): ~~[[A]]~~ The system as defined in claim 1, wherein ~~[[it]]~~ the system is embedded in hardware or software as a part of design data protection ~~[[.]], [[To]]~~ the use the hardware or software requires personal authentication with fingerprints.

Claim 16 (currently amended): ~~[[A]]~~ The system as defined in claim 1, wherein ~~criteria~~ a criterion of acceptance is ~~decided~~ determined by logic operations performed on or utilizing ~~among~~ extracted feature data of plural fingerprints.

Claim 17 (new): The system as defined in claim 10, further comprising:  
means for rotating coordinates of all minutiae to a rotation angle around a specified origin point;  
means for compensating a minutia ridge shape for rotation to the rotation angle; and  
means for employing fingerprint matching without compensation for displacement of fingerprints.